

**NATURAL REGENERATION OF LIMES (*TILIA* SPP.) IN SCOTLAND:  
Locally widespread and more numerous in 1999**

**R.K.S. Gray<sup>1</sup> and N.R. Grist<sup>2</sup>**

**<sup>1</sup>“Langdale”, 6 Prince Albert Road, Glasgow G12 9JX**

**<sup>2</sup>5A Hyndland Court, 6A Sydenham Road, Glasgow G12 9NR**

**ABSTRACT**

This paper explores the degree of lime regeneration found in Glasgow and other parts of Scotland in 1999. Regeneration was more widespread than noted previously, although summer temperatures in 1997, the year producing the fertile seeds, were not the hottest on record nor in the past decade. Detailed analysis of regeneration in one specific locality reinforced the general trends found elsewhere. We noted more vigorous development of seedlings having three cotyledons compared to those with the normal two. The higher threshold temperature sensitivity of small-leaved lime (*T. cordata*) compared to that of large-leaved lime (*T. platyphyllos*) and common (hybrid) lime (*T. x europaea*) were reflected in the seedling counts.

**INTRODUCTION**

Our previous paper forecast that “much (lime) regeneration can be anticipated in 1999 on the basis of the 1997 temperatures” (Gray *et al.*, 1999). Since it was written, this forecast was substantiated by lime regeneration mainly in the Glasgow area, and also to a lesser extent elsewhere.

**REGENERATION IN 1999**

Our earliest observation of lime seedlings (common lime, *T. x europaea*) was on 26<sup>th</sup> March, 1999 in the garden of 9 Victoria Circus in the West End of Glasgow. Three were noted.

The 1999 results show firstly, that common lime regeneration was locally abundant, measurable in hundreds, and greater than the local numbers found in previous years. Secondly, common lime regeneration was more widespread in the West End of Glasgow than in previous years. We observed it in 25 sites compared with 14 in 1998: the same sites were examined in both years.

The scale and relative increase in seedlings in 1999 is illustrated by counts of new seedlings at Hyndland Court, 6 Sydenham Road: NS 560675, which numbered 53 in 1997, 16 in 1998 and 275 in 1999 – a remarkable increase in this last year.

Small-leaved lime (*T. cordata*) regeneration showed

an increased number of seedlings at three locations as opposed to two.

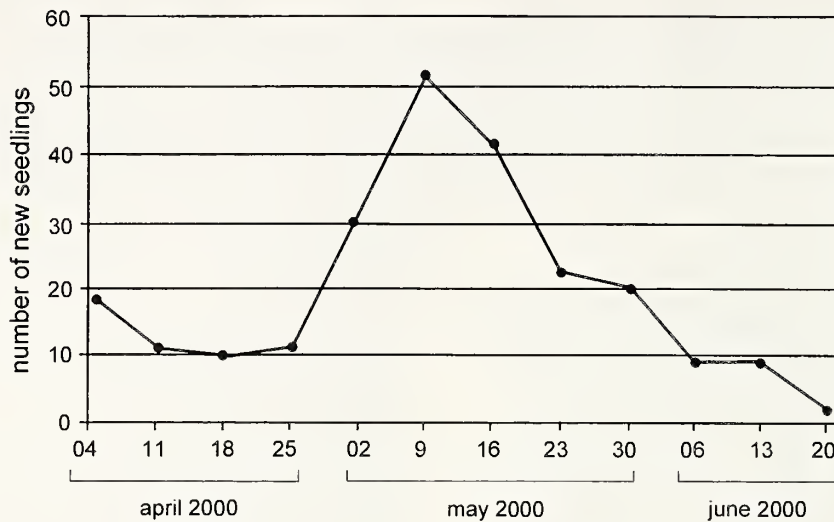
Large-leaved lime (*T. platyphyllos*) regeneration followed a similarly increased pattern in terms of number though not of location.

In the Milngavie area natural regeneration was observed in only two areas, namely, Auchenhowie – under a curious hybrid that may be a backcross – and the Community Education Centre – under *T. platyphyllos*. The paucity of natural lime regeneration in the Milngavie area may have been due to excessive moisture, causing ground conditions to be unsatisfactory for germination. Germination occurred in spring, 1999 of large-leaved lime seeds previously collected from six locations in the Milngavie area, namely, Allander walkway, C.E. Centre, Drymen Road, Kilmardinny House and the wooden bridge on Clobber Road (Hansen, personal communication).

Flowering of *T. platyphyllos* was first noted in the Milngavie area on 9<sup>th</sup> July, about two weeks after flowering at the lower, more sheltered altitude of the West End of Glasgow.

Outwith the Glasgow area 48 seedlings were found under a number of large-leaved limes in the grounds of Dalzell House, Motherwell where also 10 seedlings were discovered under a few common limes. Some 63 seedlings were observed under a single *T. platyphyllos* in the Royal Botanic Garden, Edinburgh in the spring of 1999. Reports were received of regeneration of *T. x europaea* in Darvel, Ayrshire and Cardross, Dunbartonshire. Hence it is evident that limes can produce fertile seed over a wide part of the central lowlands of Scotland from Glasgow to Edinburgh, Ayrshire, Dunbartonshire and north Lanarkshire. Previous reports extend this area as far north as Perth (Gray *et al.*, 1999).

**Figure 1:** Numbers of new seedling limes (*T.x europaea*) emerging each week in Plot A, Hyndland Court, Glasgow – 1999



**Hyndland Court**

New seedlings in the whole garden numbered 275 in 1999, most of them in one grass plot. Close observations of this 64 m2 plot of mossy grass with one of the row of limes (*T. x europaea*) in its corner showed a total of 235 emergent seedlings in April-June, most of which surfaced in early May (Fig. 1). Three of these had three instead of the normal two cotyledons. Two of these were potted, as were 5 of the normal seedlings, one of which died. It was soon evident that the seedlings with three cotyledons grew more vigorously than the others (Table 1). All those in pots, including five from 1998 and one from 1997, survived in the roof garden whereas most of those in the ground below were destroyed by gardeners strimming, damaged by trampling or grazed apparently by invertebrates as in previous seasons, or plucked for pressing before the gardeners strimmed the plot in July. Invertebrates damaged leaves in the roof garden also, including the darker green leaves of seedlings 99.1 & 99.2 which were reduced to lacework.

The crop of 235 seedlings under one lime contrasts with the single seedling in a similar area of mossy grass a few metres farther north in the garden adjacent to two other common limes in the same row. This difference further supports our view that the different genetic constitution of individual limes is important to their ability to produce fertile seeds.

**FACTORS AFFECTING REGENERATION**

*Temperature*

It was on the basis of the temperature data above the 20 degree threshold for both July and August, 1997 that the forecast was made of substantial lime regeneration in 1999. If temperature were the sole determining factor controlling lime fertile seed formation and subsequent regeneration the number of seedlings anticipated in 1997 (on the basis of the 1995 temperature data) would have been greater than in 1999.

**Table 1: Comparison of potted seedlings in July & September, 1999**

Seedling no.	No. of cotyledons	Leaves (no.)	Leaves (no.)	Leaf max. size (mm.)	Height (mm.)	Height (mm.)	No. lateral branches
		25 July	12 Sept	12 Sept	25 July	12 Sept	12 Sept
99.1*	3	7+	5+	42	40	45	2
99.2*	3	9+	9	45	35	43	2
99.3	2	3	3	n.r.	25	33	0
99.4	2	2	0 eaten	0	15	33	0
99.6	2	n.r.	1	remnant	n.r.	30	0
99.7	2	n.r.	3	tiny	n.r.	25	0

n.r. = not recorded

Leaf numbers reduced in late summer by predation by slugs etc.

\* = on Aug. 3rd these seedlings were potted on because of their more vigorous growth.

The opposite was the case. The 1996 temperatures suggest less germination in 1998 than in either 1997 or 1999 as was certainly the case for both *T. x europaea* and *T. platyphyllos*. The lack of precise correlation between temperature and amount of regeneration indicates the operation of factors other than temperature alone in controlling lime regeneration. Exact correlation is not to be expected since the temperature records were not from within the northwest area of Glasgow itself. Also environmental conditions between the time of fertilisation and regeneration may differ.

The smaller amount of *T. cordata* regeneration observed reflects the higher temperature requirement for fertilisation compared to *T. platyphyllos* and *T. x europaea* (Pigott, unpublished).

On the basis of the 1998 temperature data, adjusted to sea level, since neither the July nor August figures achieved the 20 degree threshold, it was anticipated that little or no new germination would occur in spring, 2000. In the event, however, from March 19<sup>th</sup>, 2000 the cotyledons of new seedlings have been appearing under *T. x europaea* and *T. platyphyllos* and our observations continue. These seedlings may result either from fertile fruit formation in 1998 or represent the remains of the 1997 fruiting year.

**Moisture**

It has been shown experimentally (Pigott, 1991) that if seed is air dried and then sown in the open, 10 – 15%

germinate after 6 months and most of the remainder after 18 months. Seed hanging on the tree is normally subjected to air drying prior to fall. Hence it was suggested in our previous paper that “If the 1998 regeneration developed from the fertilisation of the 1997 hot summer then, on a moisture basis, the anticipated percentage germination in 1999 in this area might be considerably more than in 1998.” The regeneration numbers for 1999 clearly substantiate this claim. The figures also suggest that the 1998 regeneration resulted from 10 – 15% of the 1997 fertilised seed, although it is possible that some of this 1998 regeneration arose after 18 months from 1996 when the July/ August monthly mean temperature maxima almost reached the 20°C. threshold.

**SURVIVORS**

Survivors refer to specimens one or more years old, i.e. survivors from previous years.

It is apparent from the tables that survival of any seedling beyond the one year stage is fairly uncommon in this area. The apparent decline of *T. platyphyllos* numbers from 10 to 6 probably has more to do with the difficulties associated with observing these saplings within a tended privet hedge than any real change in their numbers.

**Table 3: Sites of Natural Regeneration 1999**

**Table 2: Summary of Lime Regeneration in 1997, 1998 & 1999**

species	survivors '99	survivors '98	New in '99	New in '98	New in '97
<i>T. x europaea</i>	7 (0 saplings)	24 (0 saplings)	several hundreds	>50<100	100's
<i>T. platyphyllos</i>	12 (incl. 6 saplings)	36 (incl. 10 saplings)	145	13	>40
<i>T. cordata</i>	2 (incl. 2 saplings)	3 (incl. 2 saplings)	20	2	0

**Table 4: Monthly Mean Temperature Maxima (degrees C.) (Mugdock\* 1999, Abbotsinch 1998 to 1996 and Renfrew 1995)**

	1999	1998	1997	1996	1995
June	15.6	16.7	17.9	18.0	19.5
July	18.9	17.9	20.3	19.2	20.8
August	18.1	18.5	21.6	20.2	22.8
September	16.6	17.0	16.6	17.7	16.7

\*Mugdock (160 metres above sea level) temperatures amended using the lapse rate of 1°C. per 160m

### *T. x europaea*

9 Victoria Circus. On 26/3/99 – 3 seedlings.  
Hughenden Lane. SE corner of playing fields. On 9/4/99 – 1 seedling.  
Princes Place / Prince Albert Road. On 9/4/99 – 1 x '98 survivor in hedge.  
Great Western Road. N side. Balgray. On 9/4/99 – 20 seedlings.  
'Stazione' restaurant area. On 9/4/99 – 24 seedlings.  
Hughenden rugby stand. On 9/4/99 – 16 seedlings.  
6 Prince Albert Road lawn. On 12/4/99 – 33 seedlings.  
N-D school garden. On 12/4/99 – 4 seedlings.  
Glasgow Botanic Gardens. On 12/4/99 Under T. 'Petiolaris' – 6 seedlings. Under T x europaea – 1 seedling.  
9 Victoria Circus. On 12/4/99 – 15 seedlings.  
Balgray, W gate. On 14/4/99 – 5 seedlings.  
6 Prince Albert Road back garden. On 14/4/99 – 20 seedlings.  
6 Prince Albert Road front garden. On 14/4/99 – 33 seedlings.  
Dalzell House grounds. On 25/4/99 – 10 seedlings.  
Baron's Haugh. On 25/4/99 – 1 seedling.  
6 Prince Albert Road front garden. On 26/4/99 – 83 seedlings.  
6 Prince Albert Road back garden. On 26/4/99 – 38 seedlings.  
3 Sydenham Road. On 30/4/99 – 5 seedlings. 1 x '98 survivor in hedge.  
6 Sydenham Road. Between 2/4/99 & 20/6/99 – 235 seedlings (cf. Fig.1)  
8 Sydenham Road. On 30/4/99 – 3 seedlings.  
Prince Albert Road, S side. On 4/5/99 – 1 seedling.  
N-D school garden. On 4/5/99 – 4 seedlings.  
Crown Road North. On 4/5/99 – 30 seedlings. 4 x '98 survivors in hedge.  
Crown Terrace. On 4/5/99 – 2 seedlings.  
'Rock' car park. On 4/5/99 – 5 seedlings.  
Laurel Park School, Great George Street. On 13/5/99 – 1 seedling.  
Lilybank Gardens. On 13/5/99 – 3 seedlings.  
Queen's Gardens. On 13/5/99 – 5 seedlings.  
Princes Terrace. On 13/5/99 – 10 seedlings.  
Great Western Road, S side. On 20/6/99 – 6 seedlings.  
9 Victoria Circus. On 25/7/99 – 4 surviving '99 seedlings.  
BT Linfern Entrance. On 1/8/99 – 10 surviving '99 seedlings.  
10 Victoria Circus. On 1/8/99 – 8 surviving '99 seedlings.  
Marchmont Terrace. On 27/8/99 – 1 surviving '99 seedling.

### *T. platyphyllos*

Kingsborough Gardens. On 9/4/99 – 13 seedlings. 2 saplings flushed in hedge.  
Marchmont Terrace. On 12/4/99 – 69 seedlings.  
Dalzell House grounds. On 25/4/99 – 48 seedlings.  
Kingsborough Gardens. On 4/5/99 – 14 seedlings. 2 x '98 survivors, 6 older survivors.  
Knightswood Triangle. On 5/5/99 – 1 seedling.  
Marchmont Terrace. On 27/8/99 – 27 surviving '99 seedlings. 4 x '98 survivors.

### *T. cordata*

Kingsborough Square, N side. On 9/4/99 – 2 seedlings.  
Kingsborough Square. On 4/5/99 – 12 seedlings.  
Crown Terrace. On 4/5/99 – 2 seedlings.  
Victoria Circus, Northcote Surgery. On 1/8/99 – 4 x '99 survivors.

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